RESEARCH ARTICLE OPEN ACCESS

The existing problems of the bridge bearing capacity evaluation of asymmetric T type section

Li Teng-fei, Zhao Bing

(School of Civil Engineering and Architecture, Chongqing Jiaotong University, Chongqing 400074)

Abstract

Usually Grillage method commonly used and seeking lateral distribution coefficient method are based on solving the bridge in both internal forces and stress Symmetrical cross-section of the bridge. Therefore,this algorithm exists such a problem on bridge section asymmetry. In this paper, the finite element software beam elements were established, and a comparative analysis of solid elements to prove Grillage method and lateral distribution coefficient method in the calculation of internal forces of asymmetric cross section of bridge defects.

Keyword: Asymmetrical section, Transverse bending moment, Grillage method

I. Introduction

The progress of science and technology makes rapid development of bridge structure calculation software. The most common form of bridge is symmetrical section,Even if the section is asymmetric , there is only a very small gap between the left and rightflank plate length or thickness, and the influence caused by the asymmetry section can be still ignored. Some bridges side wing plate is almost finished cutting. There is no clear method of calculation to calculate Influence caused by the serious asymmetry of bridge structure. Whether can use the Grillage method to assess the bridge carrying capacity?

II. Bridge Survey

This project is a 40m span prestressed concrete simply supported Beam Bridge in China. The cross section is composed of 7 pieces of T beams, The girder spacing is 2.14m. The bridge is made of 7 beams with the T section. All the beams are quite the same In the early stage. But later in order to build the overpass wiring, we have to cut on outboard T beam to form a transition section. The width of T beam lateral flange is reduced from 1.06M to 0.33m.See Figure 1. The circles represent the prestressed rein for cement anchor points in Figure 1.After cutting .Whether the carrying capacity of the bridge construction is able to achieve the requirements of the standard, the assessment of structural safety is necessary.

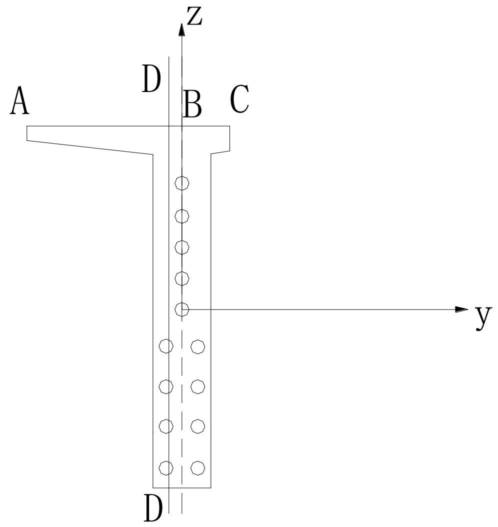

Figure 1：T beam section

III. Analysis and calculation

On the basis of grillage method principle I establish the spatial beam element model (modelⅠ),using the bridge structure calculation software Midas civil from Korea. From the software calculation results, because of the long-term load, Tensile stress appears on the end roof of outside beam. This result has not meet the requirement of prestressed structure. calculation results using this software to build a single-beam model (model Ⅱ) also show that Tensile stress appears on The end roof . In order to find the reason I establish complete bridge without cutting the wing plate of model(model Ⅲ). I extracted stress data from the sections which are 2 meters distance from the end of the beam. Both sides and middle point of the roof are the extracted points.

Models	A(MPa)	B(MPa)	C(MPa)
ModelⅠ	-1.2	1.84	3.1
ModelⅡ	-3.4	1.93	4.1
ModelⅢ	1.5	1.5	1.5

Notice： Pressure is "+", tension is"-"A is the point on left side ,C is the point on right side, and B is in the middle.

As can be seen from the results, the normal stress on the T-beam top of model Ⅲ is the same,when it comes model Ⅱ,it is asymmetry and the impact of T-beam wing cutting is relatively large.According to mechanical analysis, stress causes asymmetric left and right side only to produce transverse moment.After cutting the flaps, the moment of inertia changes. Andthe position of the neutral axis is moved to the left of the 8cm,from y axis toDD axis,causing prestressing asymmetric about the neutral axis, resulting in a moment M on the axis EE, it generates tensile stress at A and compressive stress at C.So the formula section stress should be$\sigma=\frac{N}{A}\pm\frac{My}{I_z}Z\pm\frac{Mz}{I_z}y$ instead of $\sigma=\frac{N}{A}\pm\frac{My}{I_z}Z$.

Based on the above analysis and speculation, extracted from the model Ⅰ transverse moment, and it reaches -399.14kN * m.Upon the formula σ= in Mechanics of Materials ,We can see the tensile stress produced only by cross-bridge reaches -5.25MPa at A,and the compressive stress is 2.15MPa at C .If the plane model adopted, the roof is stress, and the results are consistent with the modelⅢ.For the symmetrical cross bridge, there is no moment in the transverse direction, Transverse to the moment is the root cause of stress roof appear inconsistent.

Commonly used to calculate the force bridge girder grid method and the transverse distribution coefficient method is mainly used for each piece beam load distribution in the vertical direction, and usually the main beam computed mostly symmetrical, prestressing load and center of gravity in the shaft, there is no cross-bridge to the moment.As the premise of the calculation method has changed,the authenticity of the results of is questionable.Practice has proved that the bridge construction is completed and running well, without any adverse reactions, so the foregoing calculation methods do exist some problems.

From the actual structure of the force forms from the bridge view, due to the late pouring concrete ,the deck has become a whole, According to a monolithic edge beam to bear transverse moment, obviously the calculation is too conservative. From the moment diagram of the transverse direction the in the model of the entire bridge, Transverse affected not just the moment of the range edge beam, the within beam also received a certain range of the impact of the moment. With respect to the entire cross-section, moment of inertia of the wing cutting edge beam impact on the entire cross-section is very small,and the moving of the neutral axis is very small, and can negligible. But the transverse direction of the moment of inertia can not simply use the plane assumption to calculate the moment of inertia. Therefore, the scope of impact is more difficult to define the lateral bending moment For a clearer analysis of the actual stress of the bridge,Midas FEA use solid models were established full-bridge（Model Ⅳ)before cutting,entity model after cutting flap of the full-bridge（Model Ⅴ),Single-beam model after cutting flap（Model Ⅵ).Extractof stress of the section in same position from different models and see Figure 2to4.

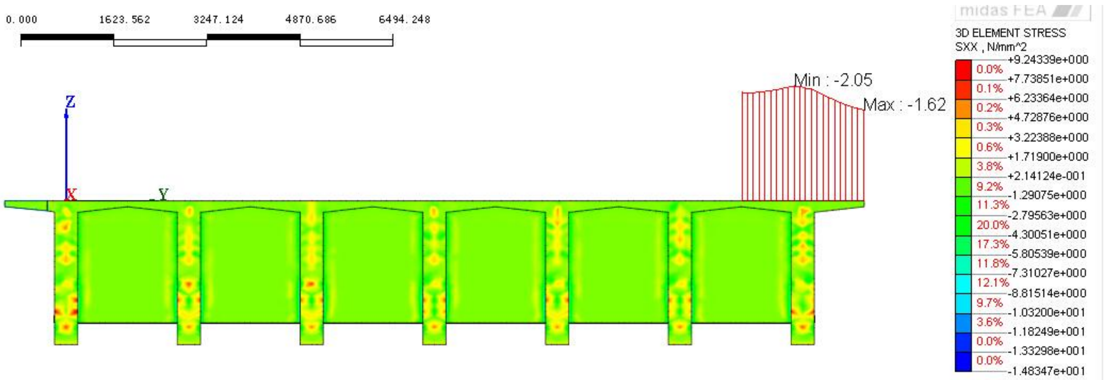

Figure 2Model ⅣStress nephogram

Figure 3 Model ⅤStress nephogram

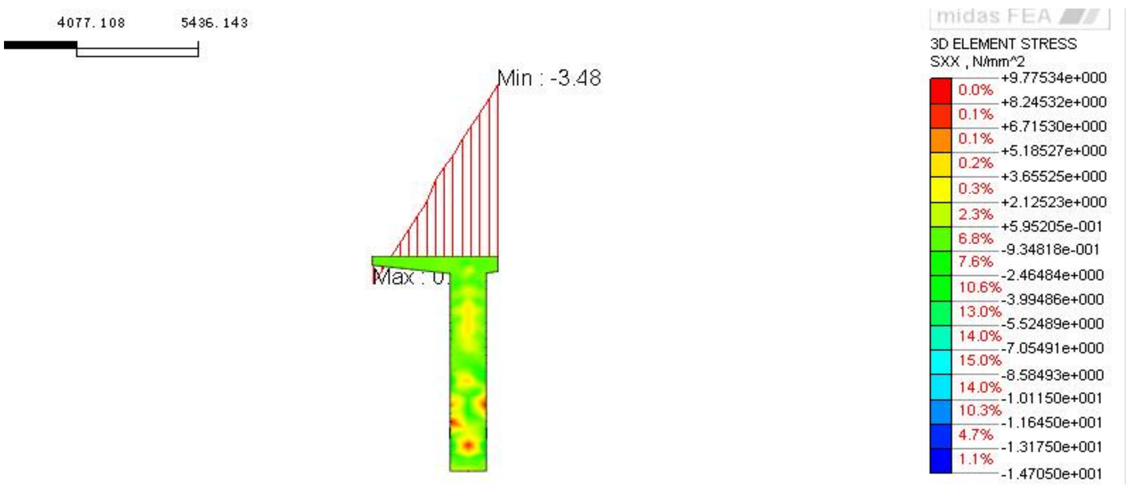

Figure 4 Model Ⅵ Stress nephogram

Notice：In Midas FEA ,pressure is “-”, tension is“+”.

Assuming the distance of the edge beam to the roof is L in each model, the corresponding stress σ,the relationship between L and σ is shown in Fig 2

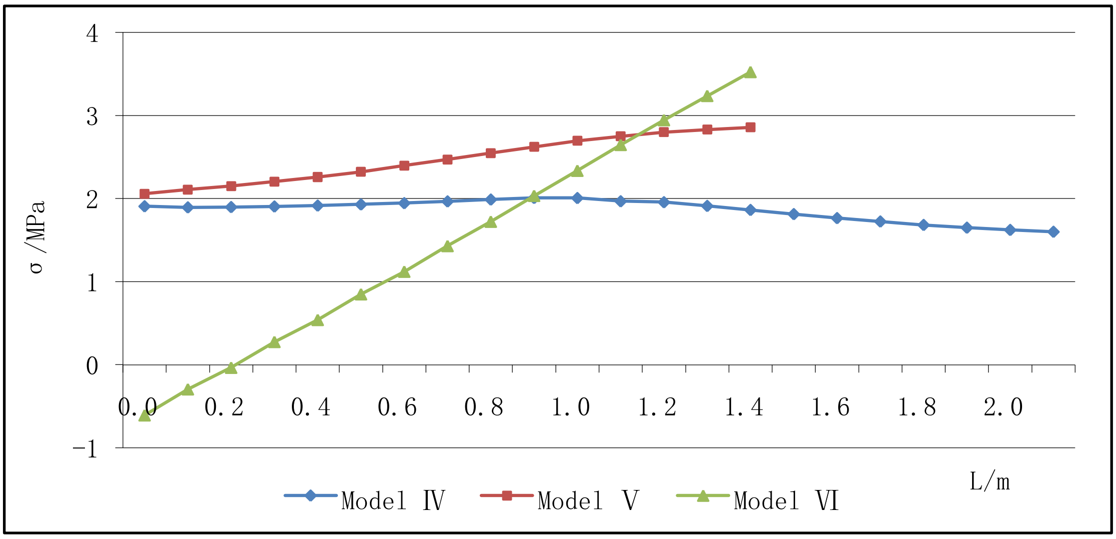

Fig 2Stress changes of roof

The following analysis results can be obtained from solid elements data:

（1）After the T-beam wing being cut off, the stress difference between left and right side in roof model Ⅵ is large, the left side of the roof does appear to be a greater tensile stress.

（2）Tensile stress did not occur at the top of the beam in model Ⅴ. Affected by the transverse bending moment,the stress difference between the left and right side of the roof is obvious, since the moment of inertia model Ⅴis lessthan the model Ⅵ's, the whole stress is greater than the solid model Ⅵ's.

IV. Conclusion

Therefore, for this kind of cutting bridge wing, it is unscientific to simple use Grillage method or seeking lateral distribution coefficient method in checking section stress.Transverse section should be given full consideration to the process of change by symmetry to asymmetry caused by the moment. And attach importance to the law, avoid misjudgment of the bridge carrying capacity.

Currently grillage method and transverse distribution coefficient method can not solve these problems.To solve such problems we need to establish solid element analysis and calculation.

For the middle section, under its own weight and prestress, originally pressure section have relatively large, more than 10MPa, Even the moment superimposed on transverse, it is impossible to produce tensile stress.

Reference

[1] DAIGonglian,LIDejian.The Design Method and Its application of Spatial Analysis of Bridge Structure Press[M]. China Communications Press, 2010.
[2] GUanbang. Bridge Engineer [M].China Communications Press, 2010.
[3] GEJunying. Midas civil operating guide [M]. China Communications Press, 2013.
[4] LI Guohao, SHI Dong. Calculation of the Transverse Load Distribution of Highway Bridge [M]. China Communications Press, 1987.
[5] SUN Xunfang. Mechanics of Materials [M]. Higher Education Press,2009.